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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b> <b>A61K 31/155, 37/14, 31/635</b> <b>A61K 31/28</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 90/04390</b> <b>(43) International Publication Date:</b> <b>3 May 1990 (03.05.90)</b>
<b>(21) International Application Number:</b> PCT/US89/04642 <b>(22) International Filing Date:</b> 17 October 1989 (17.10.89)  <b>(30) Priority data:</b> 262,165 18 October 1988 (18.10.88) US  <b>(60) Parent Application or Grant</b> <b>(63) Related by Continuation</b> US 262,165 (CIP) Filed on 18 October 1988 (18.10.88)  <b>(71) Applicant (for all designated States except US):</b> THE TRUSTEES OF COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK [US/US]; Morningside Heights, New York, NY 10000 (US).		<b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only) :</b> MODAK, Shanta, M. [US/US]; 184 Howland Ave., River Edge, NJ 07661 (US).  <b>(72) Inventor:</b> FOX, Charles, L., Jr. (deceased).  <b>(74) Agents:</b> EBERLE, William, F. et al.; Brumbaugh, Graves, Donohue & Raymond, 30 Rockefeller Plaza, New York, NY 10112 (US).  <b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.  <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i>
<b>(54) Title:</b> COMPOSITION FOR INHIBITING TRANSMISSION OF AIDS  <b>(57) Abstract</b>  An inexpensive, easily available and convenient method of inhibiting the transmission of the AIDS virus in humans as a result of sexual intercourse is provided. The invention relies upon a dual mode of action of antiviral compositions comprising biguanides such as chlorhexidine, alone or in combination with silver salts, such as silver sulfadiazine, or sodium deoxycholate. These compositions are effective to reduce the infectivity of the AIDS virus and also kill the causative organisms of many other sexually transmitted diseases (STD). The composition of the invention is therefore useful to reduce the immediate risk of AIDS transmission. It also reduces future risk of AIDS transmission by eliminating STD causing organisms which increase the risk of AIDS.		

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## Description

### Composition for Inhibiting Transmission of AIDS

#### Background of the Invention

The present invention relates to composition for  
5 inhibiting the transmission of Acquired  
Immunodeficiency Syndrome (AIDS).

AIDS is a fatal catastrophic disease that  
presently infects millions of people worldwide.  
Although initially concentrated in central Africa and  
10 in certain high risk groups in other geographic areas  
including the United States, AIDS is now spreading to  
other areas and is appearing in individuals who are  
not members of the recognized risk groups. As a  
result, major efforts are being made to develop  
15 methods of preventing the transmission of AIDS,  
methods of curing AIDS once contracted, and methods of  
ameliorating the symptoms of AIDS. To date, however,  
AIDS has proven difficult to treat or prevent.

AIDS is caused by a virus. This virus has been  
20 referred to by a number of names in the literature,  
including HIV (human immunodeficiency virus), LAV  
(lymphadenopathy-associated virus), ARV (AIDS-related  
virus) and HTLV-III (human T-cell leukemia virus-III).  
For simplicity, the virus causing AIDS will be  
25 referred to herein as the AIDS virus.

It is generally known that viruses can be divided  
into two groups based upon the nature of the virus'  
genetic material. Some viruses are DNA viruses, that  
is there genetic material is deoxyribonucleic acid,  
30 while others are RNA (ribonucleic acid) viruses. The  
RNA viruses can further be divided into two groups,  
those in which replication of the viral genome  
proceeds by making an RNA copy directly from the RNA  
genome and those in which a DNA intermediate is

involved. This latter type of RNA virus is called a retrovirus.

The AIDS virus is a retrovirus. Thus, like other retroviruses, it has an enzyme called reverse transcriptase (or RNA-dependent DNA polymerase) which catalyzes transcription of viral RNA into double helical DNA. This DNA sequence is integrated into the genome of the infected cell where it is known as a provirus. Subsequent transcription of this provirus by the transcription mechanism of the infected cell produces new viral RNA for packaging into new virus particles.

Because the AIDS virus may lie dormant in an infected cell in the form of a provirus for extended periods of time, it has been difficult to establish the precise routes by which AIDS is spread. It is known, however, that AIDS can be transmitted to a person by transfusing that person with blood containing the AIDS virus. AIDS can also be transmitted to a person through homosexual or heterosexual intercourse with a partner infected with the AIDS virus. Transmission of the AIDS virus is facilitated by preexisting sexually transmitted diseases (STD's) other than AIDS, for example gonorrhea. Further, scientists suspect that the AIDS virus is spread easily during sexual intercourse due to tearing of tissue which would abet entry of the AIDS virus into the blood stream.

In response to the growing threat of AIDS transmission, the use of condoms during sexual intercourse has been suggested as a means of preventing transmission of the AIDS virus. Improper use of condoms, or their perforation during intercourse renders them only partially effective. Accordingly, there is a pressing need for a better method of inhibiting the transmission of the AIDS virus in humans during sexual intercourse and during surgical procedures on infected patients. It is an

object of the present invention to provide such a method.

#### Summary of the Invention

The present invention provides an inexpensive,  
5 easily available and convenient composition for  
inhibiting the transmission of the AIDS virus in  
humans for example, as a result of sexual intercourse.  
The invention relies upon a dual mode of action of  
particular compounds and combinations thereof which  
10 results in a rapid killing action within minutes.  
These compounds are effective to reduce the  
infectivity of the AIDS virus and also kill the  
causative organisms of many other STD's after short  
exposure. The method of the invention is therefore  
15 useful to reduce the immediate risk of AIDS  
transmission. It also reduces future risk of AIDS  
transmission by eliminating STD causing organisms  
which increase the risk of AIDS.

Silver salts, such as silver sulfadiazine (AgSD),  
20 are among the compounds found to be effective  
antiviral agents against retroviruses including the  
AIDS virus. Such materials had previously been  
recognized as antibacterial agents useful in treating  
burns in man and animal. C.L. Fox, Jr., U.S. Patent  
25 No. 3,761,590. AgSD has also been shown to be  
effective against certain viruses such as herpes  
simplex and herpes zoster and against the causative  
organisms of many STD's including Candida albicans,  
Treponema pallidum and gonorrhea. U.S. Patent No.  
30 4,415,565 of Wysox shows further antiviral activity of  
AgSD against certain RNA viruses, but none of these  
are retroviruses. Thus, while AgSD is a well studied  
material, there was no basis to expect that it would  
have activity against the AIDS retrovirus which has  
35 proven so difficult to inhibit or destroy.

Biguanides, such as chlorhexidine, have also been found to be effective when used at sufficiently high levels as inhibitors of the AIDS virus.

We have also found that combinations of these  
5 compounds with each other and with other antibacterial agents lead to an unexpected enhancement of the antiviral activity of AgSD and also in a rapid killing action. Specifically, AgSD in combination with  
10 chlorhexidine, a broad spectrum antibacterial, is substantially more effective for reducing the infectivity of the AIDS virus than AgSD alone, despite the fact the chlorhexidine alone has no effect on infectivity of AIDS virus under the same conditions. Increased effectiveness was also noted for  
15 combinations of AgSD with detergents such as deoxycholate.

In view of these findings, the invention contemplates inhibiting the transmission of AIDS comprising topically applying an effective antiviral  
20 amount of biguanide or a silver salt such as silver sulfadiazine, alone or in combination. Other agents such as deoxycholate may also be used. The composition is advantageously administered to a sexual canal of a human prior to or during sexual intercourse.  
25 This application can be carried out by introducing a cream or foam into the sexual canal, or by coating the inhibitory composition onto a condom or other device that is inserted into the sexual canal.

#### Brief Description of the Figure

30 Fig. 1 is a graph of the rate of incorporation of radiolabeled thymidine by hepatitis B virus following exposure of the virus to AgSD alone or in combination with other agents.

#### Detailed Description of the Invention

35 As noted above, the composition of the present invention is effective to inhibit the transmission of

AIDS virus in humans and other mammals which applied topically in an effective antiviral amount. The composition comprises a biguanide, alone or in combination with other active ingredients.

- 5 As used in this application, the term sexual canal refers to either a vaginal or an anal canal.

The antiviral composition used in the method of the invention comprises biguanide, such as chlorhexidine or a salt thereof.

- 10 The composition may also include a silver salt. While the examples hereinbelow use one specific silver salt, AgSD, other silver salts may also be used. Other suitable silver salts include silver acetate, silver benzoate, silver carbonate, silver chloride, 15 silver iodate, silver iodide, silver lactate, silver laurate, silver nitrate, silver oxide, silver palmitate, and silver salts of proteins.

- The antiviral composition of the invention preferably also comprises one or more additional 20 ingredients which enhance the antiviral effectiveness of the silver salt. Thus, the antiviral composition may contain detergents such as deoxycholate or benzalkonium chloride. Suitable salts of these materials may also be used.

- 25 The antiviral composition may also include other materials which are effective against STD-causing organisms which will reduce the long term risk of AIDS infection. Examples of such materials include nonoxynol, which is effective against gonococcus and 30 quinolones which are effective against numerous STD-causing organisms. It should be noted that chlorhexidine and the detergents noted above are also effective against a variety of STD-causing organisms, including herpes simplex virus (HSV) and Candida 35 albicans.

The antiviral compositions for use in the invention can be applied as (a) a dispersion in a water-dispersible hydrophilic carrier; (b) as a

dispersion in a substantially water insoluble carrier;  
(c) as a dispersion in a semi-soft or cream-like  
water-dispersible or water-soluble oil-in-water  
emulsion carrier; or (d) as a dispersion in an aqueous  
5 sucrose carrier, e.g. an approximately 25%-50% by  
weight aqueous sucrose solution. Specific examples of  
formulating silver sulfadiazine in various carriers  
are provided in U.S. Patent No. 3,761,590 which is  
incorporated herein by reference. The carrier will  
10 preferably contain from about 0.1 to about 10% by  
weight of the silver salt and up to 2% of other active  
agents.

The antiviral composition useful in the method of  
the invention can be contained in a squeezable tube  
15 having an applicator nozzle. This facilitates topical  
application of the composition to the sexual canal  
prior to intercourse by inserting the nozzle into the  
sexual canal and squeezing the tube to force the  
antiviral composition into the sexual canal.  
20 Alternatively, the antiviral can be applied with any  
of various known applicators for delivering drugs into  
a sexual canal. The antiviral composition can also be  
topically applied during sexual intercourse by coating  
the penis itself or coating a condom with a lubricant  
25 material, such as K-Y Jelly (Johnson & Johnson), that  
contains the silver salt.

The antiviral composition of the invention may  
also be introduced into the sexual canal as a coating  
on a device intended for insertion in the sexual  
30 canal. Examples of such devices include condoms,  
medical gloves, and diaphragms. Such devices may be  
coated or impregnated with the antiviral composition  
by spraying the completed device or by incorporating  
the antiviral composition during manufacture.  
35 Specific techniques for preparing the devices are  
described in U.S. Patent Application Serial No.  
154,920, filed February 11, 1988, and its



combination-in-part filed October 14, 1988, both of which are incorporated herein by reference.

The experimental results which demonstrate the effectiveness of the claimed method are set forth below. These tests involve the AIDS virus, a recognized model system for the AIDS virus or a recognized STD organism. Further, although the tests with the AIDS virus itself are necessarily in vitro tests in view of the catastrophic consequences of AIDS, these in vitro tests are highly predictive of and correlate with in vivo efficacy. They thus support the surprising finding that compositions containing biguanides with or without silver salts can be used to inhibit transmission of AIDS as a result of sexual intercourse.

#### Example 1

The effectiveness of AgSD against the AIDS virus J1 in vitro was assessed by testing the infectivity of samples of HTLV-III in H9 cells after exposure to AgSD for 10 minutes. Due to the relatively low titers achievable with the AIDS virus, it was necessary to devise means for separating the bulk of the AgSD from the virus to be assayed. After a number of preliminary experiments, it was found that the best method of those investigated was to rapidly pass the AgSD/AIDS virus mixture over a Sephadex G-25M column, recover the AIDS virus containing void volume and precipitate the virus using polyethylene glycol (PEG).

To determine recovery of the virus using this method, a control preparation containing virus but no AgSD was similarly processed.

It was also necessary to confirm that this procedure was effective to remove all of the AgSD. This was accomplished using "Stop Controls". This involved processing AgSD alone through the column, precipitating the same fraction with PEG and then adding active AIDS virus to the precipitate. If the titer of the stop control had been similar to the

control preparation containing virus but no AgSD it would have indicated that little or no AgSD was present in the precipitate. In fact, however, the titer was substantially lower in the stop controls (Samples 4 and 6) than in the corresponding test samples without silver sulfadiazine (Samples 1 and 2). This indicates that some of the silver sulfadiazine is not being separated. While this means that virus killing occurred over a longer period than the ten minute contact time, it also suggests that the virucidal activity is fairly strong to persist even at the reduced levels.

The specific tests conducted are summarized in Table 1. For each sample to which virus was added initially, the virus sample was a stock solution prepared from a 10,000 fold concentrate of HTLV-III obtained from Bionetics Research. This material was diluted 1:10 with Conditioned Infection Medium (CIM) to form a stock solution with an actual virus titer of  $10^{5.5}$ /ml. Two AgSD stock preparations were also prepared, a 1% by weight in 50% by weight aqueous sucrose preparation and an 0.5% by weight in 25% by weight aqueous sucrose preparation.

To conduct the tests, 60  $\mu$ l aliquots of the virus stock were placed in microfuge tubes as samples 1-3 and 6 as indicated in Table 1. This was mixed with 540  $\mu$ l of the respective AgSD preparations in tubes 3 and 5 and with 540  $\mu$ l of CIM in tubes 1 and 2. Tubes 4 and 6 each received 600  $\mu$ l of the respective AgSD preparations, but no virus. Each tube was then mixed with a vortex mixer and allowed to incubate for 10 minutes at room temperature.

To separate the AgSD from the virus, the contents of each tube containing AgSD then centrifuged in a microfuge for 1 minute, and the supernatants were collected. These supernatants and the entire sample of tube 2 were then introduced onto a Sephadex-25M column. The columns used had a fitted disc at the top

of the column and a void volume of approximately 1 ml. These columns are normally stored in sodium azide and had been prepared by washing under sterile conditions with 18 successive 4 ml portions of CIM medium on the day prior to the experiment.

Each of the samples was placed on the column until it passed through the fitted disc. The column was then eluted with 4 ml of CIM medium. The first 3 ml of eluent was discarded and the last ml was collected into a sterile microfuge tube containing 0.35 ml of 30% PEG 6000 in phosphate buffer. These tubes were held at 0°C for at least 30 minutes and then centrifuged for 1 minute in a microfuge. The pellets were collected and resuspended in either 0.5 ml CIM (samples 2, 3 and 5) or in an HTLV-III containing medium made by diluting 0.7 parts of the virus stock with 6.3 parts of CIM.

Each of the six samples thus prepared was assayed in quadruplicate with 10-fold dilutions in CIM for its ability to infect H9 cells. This was done by adding 50 µl of a preparation containing  $2.4 \times 10^6$ /ml H9 cells that had been conditioned in CIM for 1 hour at 37°C to each 100 µl of sample or dilution. This culture was fed 25 µl of CIM on days 4, 7 and 10. On day 4, cytotoxicity was evaluated by visual examination of the cultures.

The results of these observations are shown in Table 1. As can be clearly seen, AgSD substantially reduced the infectivity of AIDS virus tested without any observation of cytotoxicity.

#### Example 2

The effect of AgSD, chlorhexidine and sodium deoxycholate, both individually and in combination, on the infectivity of the ARV-2 strain of AIDS virus was tested in H9 cells using lower concentrations of drug such as can be practically coated onto a glove or condom or other device. These concentrations were below the level that produced substantial observable

cytotoxicity, even during incubation with the virus, and yet were effective at killing the virus.

A stock solution of virus containing 3 to 5 X 10<sup>4</sup> infectious virus particles/ml was preincubated with the various drugs as indicated in Table 2 for 15 minutes. The virus sample was then diluted 4-fold in order to reduce the concentrations of the drugs below levels toxic to H9 cells (see Example 3 below) and mixed with 250,000 H9 cells in a total volume of 1 ml. After 24 hours, the cells were assayed to determine the percentage of the culture expressing viral antigen. This time interval was selected as it allows for only a single round of viral infection to have occurred such that the number of cells infected was a direct reflection of the number of infectious virions present in the original sample.

As can be seen from Table 2, AgSD alone at these low concentrations was only slightly effective, but better results were obtained when AgSD was used in combination with either sodium deoxycholate and chlorhexidine. Of particular significance is the marked reduction in infectivity observed for the combination of AgSD (5 µg/ml) and chlorhexidine (5 µg/ml) since chlorhexidine (10 µg/ml) did not itself reduce viral infectivity.

### Example 3

The toxicity of the various agents used in the antiviral compositions of the invention to human T<sub>4</sub>-lymphocytes (H9 cells and macrophages which are the carriers of the AIDS virus may be relevant to the effectiveness of a drug. This is because killing these cells when present in semen or vaginal fluids may lead to release of virus making it more susceptible to the effects of the drug. With this in mind, the effect of short exposure (10 minutes) of AgSD and other drugs on H9 cells was tested by treating a suspension of H9 cells (1.6 X 10<sup>6</sup>/ml in HBSS) with 50 and 100 µl/ml of each drug or drug

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combination. After incubating for 10 minutes, the cells were washed twice in thirty volumes of HBSS; resuspended in RPMI 10% FCS + NaPyruvate and plated into 24 well plates at  $4 \times 10^5$  cells/ml. Cell viability was determined after 24 hours and is reported as numbers of viable cells per ml and viable percentage (live cells/live cells + dead cells) in Table 3A. As can be seen, each of the agents tested kills some of the cells, although the most significant killing is observed for 100  $\mu$ l/ml AgSD and the combination of AgSD and sodium deoxycholate.

The effectiveness of killing of macrophages was also tested as shown in Table 3B. In the experiment, peritoneal normal mouse macrophages were enriched by attaching to petri dishes and adjusted to a cell concentration of 5 to  $10 \times 10^6$ /ml. 0.1ml aliquots of this suspension were plated in microtiter plates and 10 $\mu$  and 5 $\mu$  of each of four samples was added. The control plate received PBS only. After 20 minutes of incubation in a CO incubator, the cells were tested for viability using trypan-blue dye. The percent kill is shown in Table 3B.

#### Example 4

In vivo tests were performed using Rauscher Leukemia Virus (RLV), a recognized retrovirus model (see, e.g., Nature 323, 467-469 (1986); Rupecht et al., Proc. Nat'l. Acad. Sci. USA 82, 7733-7737 (1985)) which is used by the FDA in testing drugs for use in treating AIDS. RLV was introduced into Balb/CICR mice in which it infects the spleen. The level of virus infectivity was quantified by determining the weight increase of the mouse spleen after 20 days from infection.

A preliminary experiment was first carried out to determine the effect of the drugs to be tested on the spleen. Nine sets of five mice each (6 week old female mice) received 0.25 ml injections into the tail

vein of one of an extract of a glove treated with one of the following solutions:

1. Silver Sulfadiazine (2%)
2. Sodium Deoxycholate (2%)
- 5 3. Chlorhexidine (2%)
4. Silver Sulfadiazine (1%) + Sodium Deoxycholate (1%)
5. Silver Sulfadiazine (1%) + Chlorhexidine (1%)
- 10 6. Fusidic Acid (2%)
7. Fusidic Acid (1%) + Chlorhexidine (1%)
8. Saline incubated glove
9. Saline-no glove

15 Each treatment was prepared by incubating 1.5 ml Dulbecco's Phosphate Buffered Saline (PBS) for 10 minutes at 37°C in the finger tip of a latex glove. After incubation, as much as possible of the material was removed from the glove. 0.4 ml of PBS was then  
20 introduced into the glove and this was the sample which was introduced into the animals. The animals that did not receive a clean stick during the injection were excluded from the study. Thus two of the groups only had four animals each that were  
25 considered.

Eight days after injection each of the animals was sacrificed and the spleen weights determined for each animal. No increase in spleen weight was observed in any of the groups.

An additional eleven groups of 5 mice each were then used to test the effectiveness of these same compounds against infectivity of RLV. Each treatment was prepared by incubating 0.4 ml sterile PBS containing RVB3 (a strain of RLV) for 10 minutes in a glove tip which had previously had one of drugs or straight PBS incubated in it as described above. Three additional controls, a PBS containing glove with no virus, a virus sample not incubated in a glove, and a PBS sample not incubated in a glove were also run. The mice in this case were sacrificed 20 days after injection and spleen weights determined as shown in Table 4. Each of the materials tested showed a substantial reduction in virus infectivity.

15 Example 5

The combination of AgSD with chlorhexidine and deoxycholate was also found to be particularly effective against several STD-causing organisms. As shown in Tables 5A and 5B silver sulfadiazine in combination with chlorhexidine or sodium deoxycholate is particularly effective against *Candida albicans*. Similarly, these combinations are effective to kill *Gonococcus* (Table 6) and herpes virus (Tables 7A and 7B).

25 Example 6

The effect of AgSD alone or in combination with chlorhexidine or sodium deoxycholate on DNA synthesis by Hepatitis B Virus was studied by measuring the rate of incorporation of radiolabeled thymidine. As a result, it was found that the AgSD interferes with the RNA-dependent DNA polymerase of Hepatitis B virus, an interference which is enhanced by using it in combination with either chlorhexidine or sodium deoxycholate (Fig. 1).

35 Example 7

The effect of chlorohexidine on HIV-I was tested using a 4% chlorohexidine gluconate (CHG) hand scrub (HIBICLENS®) and an 0.5% CHG-containing hand rinse

(HIBISTAT®). In each case, an HIV-I preparation was exposed to dilutions of one of the two materials for 10 minutes after which the viral preparation was used to infect C3-44 cells. The presence of HIV-I

5 infection was monitored by indirect immunofluorescence by detecting viral p24 antigen expression and by reverse transcriptase activity in culture fluid as a measure of virus production. The results of this experiment showed that, chlorohexidine gluconate at

10 concentrations of 0.04%, 0.05% and higher were effective to prevent HIV-I infection, while concentrations of 0.01% and lower were not. Thus, it appears that a threshold level of chlorohexidine is necessary for activity and that the results in

15 Example 2 can be attributed to the use of chlorohexidine at a level below this threshold.



TABLE 1

## ASSAY MIXTURES AND RESULTS

Sample No.	Material	HTLV-III (Stock 21) 10 <sup>-1</sup>	Mixture CIM	AgSD	Stop Procedure	PEG Pellet Resuspended in (0.5ml)	Log <sub>10</sub> TCID <sub>50</sub> Per/ml	Log <sup>***</sup> Kill Cytotoxicity
1	HTLV-III (Stock 21) (10 <sup>-1</sup> )	60ul	540ul	-	-	-	4.5	-
2	"	"	"	-	Column + Peg	CIM	4.25	-
3	1% AgSD in 50% aqueous sucrose solution	"	-	540	Cent. *	CIM	2.0	2.25
4	"	-	-	600	"	10 <sup>-2</sup> HTLV-III (Stop Control)	3.25	-
5	0.5% AgSD in 25% aqueous solution	60ul	-	540	"	CIM	2.25	2.0
6	"	-	-	600	"	10 <sup>-2</sup> HTLV-III (Stop Control)	3.75	-

\* Centrifuge 1 minute in microfuge - place supernatant on column

\*\* TCID<sub>50</sub> = Tissue Culture Infecting Dose<sub>50</sub>

\*\*\* Compared to Sample NO. 2

TABLE 2

	<u>Drug During</u> <u>Incubation (ug/ml)</u>	<u>Final</u> <u>(Drug) ug/ml</u>	<u>%</u> <u>Infection</u>	<u>% Infection</u> <u>v. Control</u>
5	chlorhexidine (CHA) 10	2.5	3.35	108
	sodium deoxycholate (NaDC) 40	10.0	3.35	108
	AgSD 10	2.5	2.95	95
10	AgSD + NaDC 10 40	2.5 + 10.0	2.85	92
	AgSD + CHA 5 + 5	1.25 + 1.25	2.45	72

TABLE 3A

		<u>Viable Cells/ml</u>		<u>% Viab**</u>
	*AgSD 50	$4 \times 10^5$	Cells in terrible condition.	37
	100	$5 \times 10^4$	" " " "	0
5	CHA 50	$1.5 \times 10^6$		73
	100	$2.5 \times 10^5$	" " " "	20
	NaDC 50	$1.2 \times 10^6$		73
	100	$2.0 \times 10^6$		44
10	AgSD 50	$1.5 \times 10^4$		0
	+ CHA 50			
	H <sub>2</sub> O	$3.1 \times 10^6$		89
	Cells Alone	$3.0 \times 10^6$		88

15 \* AgSD → insoluble. In an attempt to remove drug cells were spun at 200g for 15 sec. (including acceleration and deceleration time) → Cells pipetted off, then washed two times.

\*\* live cells  
live & dead

TABLE 3BResultsRate of Killing of Macrophage by Drugs

		<u>% Kill</u>
5	Control	36
	AgSD (100 µg)	100
	CHA (100 µg)	100
	AgSD + CHA (50 µg + 50 µg)	85

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TABLE 4

		<u>Results</u>		
	<u>Drug in Glove</u>	<u>Concentration of Drug in Coating Solution (%)</u>	<u>Weight of Spleen (mg) (Average of 6 Animals)</u>	<u>Weight Increase from Control (mg)</u>
5	Silver sulfadiazine	2	106	20
	Deoxycholate	2	109	23
	Chlorhexidine	2	234	148
10	Silver sulfadiazine + deoxycholate	1+1	115	29
	Silver sulfadiazine + chlorhexidine	1+1	103	17
	Fusidic acid	2	107	21
15	Fusidic acid + Chlorhexidine	1+1	319	23
	Control glove + PBS medium		86	0
20	No glove - only PBS medium		86	0
	Control glove + RVB3		1,627	1,541
	No glove + RVB3		1,280	1,194

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TABLE 5A

Rate of Killing of Candida-albicans  
by silver sulfadiazine an other  
agents on short exposure

5	<u>Drug</u>	<u>Concentration</u>	<u>Colony Counts in Culture .</u> <u>(10 Minute Incubation)</u>
	Silver sulfadiazine	100	10,000
	Chlorhexidine	100	30
	Deoxycholate	1,000	8,000
10	AgSD + Chlorhexidine	50 + 50	0
	AgSD + Deoxycholate	100 + 100	20
	Nonoxynol	0.2%	>50,000
	Control		>50,000

15 3ml of Saboraud broth containing  $10^5$  organisms of Candida albicans were incubated with the above drugs. Aliquots were removed at 5 and 10 minutes and were subcultured.

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TABLE 5BAntibacterial Efficacy of Drug Coated Gloves  
against *Candida albicans*

Treated glove fingers were draped over the top of culture  
 5 tubes with the treated side forming the inside of the cup  
 shape. Then 3.0ml of TSB containing  $10^3$  organisms of *Candida*  
*albicans* was dispensed in each finger and all placed in the  
 water bath shaker at 37°C. Samples were removed at 15  
 minutes, 1 hour, 2 hours, and 4 hours. They were diluted 1-  
 10 10 and plated on blood agar in 2.0ml amounts.

<u>Drug in Glove</u>		<u>Colony Counts in Culture</u>			
		<u>15 Minutes</u>	<u>1 Hour</u>	<u>2 Hours</u>	<u>4 Hours</u>
	None (Control)	1,400	2,000	4,000	6,000
	Chlorhexidine	75	0	0	0
15	Silver Sulfadiazine	1,650	1,500	1,500	2,200
	Silver Sulfadiazine + Chlorhexidine	0	0	0	0
	Silver Sulfadiazine + Deoxycholate	1,500	400	0	0
20	Silver Sulfadiazine + Chlorhexidine + Nonoxynol	0	0	0	0

TABLE 6

Killing of Gonococcus by  
Silver Sulfadiazine and Other Agents

5	<u>Drugs</u>	<u>ug/ml</u>	<u>Colony Counts in Culture</u>	
			<u>5 Minutes</u>	<u>10 Minutes</u>
	AgSD	100	4,000	2,000
	Deoxycholate	1,000	12,000	4,000
	Chlorhexidine	100	2,000	10
	Nonoxynol	0.1%	40	70
10	AgSD + Chlorhexidine	50 + 50	0	0
	AgSD + Deoxycholate	100 + 1,000	10	0
	None (Control)		>50,000	>50,000

- 15 Drugs were suspended in 5ml of cultures containing 10<sup>5</sup> organisms of gonococcus and incubated. Aliquots were removed at 5 and 10 minute intervals and subcultured for colony counts.



TABLE 7AToxicity of Drugs for HSV

One ml HSV at  $3 \times 10^6$ /ml was incubated with 200  $\mu$ litres of drugs each 500 $\mu$ g/ml stock solution. After 20 minutes at

- 5 R.T., the virus was titered on monolayers of vero cells, incubated for 2 hours, then overlayed with methyl cellulose. Virus titers were read after 48 hours. No drug toxicity\* was seen in rows titer read in.

	<u><math>\mu</math>litres added to 1ml Virus</u>	<u>Titer</u>	<u>% Inhibition</u>
10	200 AgSD	$5.2 \times 10^5$	81
	200 Chlorhexidine	$2.7 \times 10^6$	0
	100 AgSD + 100 Chlorhexidine	$1.5 \times 10^4$	99.5
	200 NaDC	$3.2 \times 10^6$	0
15	100 NaDC + 100 AgSD	$1.3 \times 10^6$	54
	100 NaDC + 100 Chlorhexidine	$8 \times 10^4$	93
	200 Benzalkonium chloride	$5.2 \times 10^4$	98
	200 H <sub>2</sub> O	$2.8 \times 10^6$	0
20	200 Media	$3.3 \times 10^6$	0

\* Drug conc. in first row was 4-8 $\mu$ g/ml

TABLE 7BEffect on HSV-1 of Interaction with Drug Treated Gloves

HSV-1 was diluted to  $3 \times 10^6$  PFU/ml in DME 10% FCS. One ml of virus was placed in sterile drug treated gloves, incubated for

5 10 min. at room temperature then titered on Vero cells.

	<u>Treatment</u>	<u>Titer (PFU/ml)</u>
	virus (no glove)	$2.9 \times 10^6$
	virus + control tube	$3.0 \times 10^6$
	virus + tube w	$4.3 \times 10^6$
10	virus + tube x	<10
	virus + tube y	<10

W = Silver sulfadiazine

X = Silver sulfadiazine + Deoxycholate

Y = Silver sulfadiazine + Chlorhexidine

Claims

1. A topical composition for inhibiting transmission of sexually transmitted diseases including AIDS and hepatitis characterized in that the composition comprises an effective antiviral amount of a biguanide.
2. A topical composition according to claim 1, characterized in that the biguanide is chlorhexidine or a salt thereof.
3. A topical composition according to claims 1-2, characterized in that the composition further comprises a silver salt in an amount which with the biguanide exhibits synergistic antiviral activity.
4. A topical composition according to claim 3, characterized in that the silver salt is selected from among silver sulfadiazine, silver acetate, silver benzoate, silver carbonate, silver chloride, silver iodate, silver iodide, silver lactate, silver laurate, silver nitrate, silver oxide, silver palmitate, and silver salts of proteins.
5. A topical composition according to claim 4, characterized in that the silver salt is silver sulfadiazine.
6. A topical composition according to claims 1-5, characterized in that the composition further comprises a detergent.
7. A topical composition according to claim 6, characterized in that the detergent is sodium deoxycholate.

8. A topical composition according to claims 1-7, characterized in that the composition is a dispersion in a water dispersible hydrophilic carrier.
- 5 9. A topical composition according to claims 1-7, characterized in that the composition is a dispersion in a semi-soft or cream-like, water dispersible or water soluble oil-in-water emulsion.
- 10 10. A topical composition according to claims 1-7, characterized in that the composition is a dispersion in an aqueous sucrose solution.
11. A topical composition according to claims 3-10, characterized in that the composition comprises  
15 0.1 to 10 percent by weight of the silver salt.
12. A topical composition for inhibiting transmission of hepatitis B virus, characterized in that the composition comprises an effective antiviral amount of a silver salt.
- 20 13. A topical composition according to claim 12, characterized in that the silver salt is selected from among silver sulfadiazine, silver acetate, silver benzoate, silver carbonate, silver  
25 chloride, silver iodate, silver iodide, silver lactate, silver laurate, silver nitrate, silver oxide, silver palmitate, and silver salts of proteins.
14. A device for insertion in a sexual canal, characterized in that the device is coated with a  
30 composition accorded to any of claims 1-13.

15. A device for insertion in a sexual canal, characterized in that the device is impregnated with a composition according to any one of claims 1-13.

5 16. A device according to claims 14-15, characterized in that the device is a condom.

## AMENDED CLAIMS

[received by the International Bureau on 19 March 1990 (19.03.90)  
original claim 3 cancelled; claim 1 amended; claims 4-16 unchanged  
but renumbered as claims 3-15; new claims 16-18 added (3 pages)]

1. A topical composition for inhibiting transmission  
of sexually transmitted diseases including AIDS  
and hepatitis characterized in that the  
composition comprises an effective antiviral  
amount of a biguanide and a silver salt in an  
amount with which the biguanide exhibits  
synergistic antiviral activity.
2. A topical composition according to claim 1,  
characterized in that the biguanide is  
chlorhexidine or a salt thereof.
3. A topical composition according to claims 1-2,  
characterized in that the silver salt is selected  
from among silver sulfadiazine, silver acetate,  
silver benzoate, silver carbonate, silver  
chloride, silver iodate, silver iodide, silver  
lactate, silver laurate, silver nitrate, silver  
oxide, silver palmitate, and silver salts of  
proteins.
4. A topical composition according to claim 3,  
characterized in that the silver salt is silver  
sulfadiazine.
5. A topical composition according to claims 1-4,  
characterized in that the composition further  
comprises a detergent.
6. A topical composition according to claim 5,  
characterized in that the detergent is sodium  
deoxycholate.
7. A topical composition according to claims 1-6,  
characterized in that the composition is a

dispersion in a water dispersible hydrophilic carrier.

- 5 8. A topical composition according to claims 1-6, characterized in that the composition is a dispersion in a semi-soft or cream-like, water dispersible or water soluble oil-in-water emulsion.
- 10 9. A topical composition according to claims 1-6, characterized in that the composition is a dispersion in an aqueous sucrose solution.
10. A topical composition according to claims 1-9, characterized in that the composition comprises 0.1 to 10 percent by weight of the silver salt.
- 15 11. A topical composition for inhibiting transmission of hepatitis B virus, characterized in that the composition comprises an effective antiviral amount of a silver salt.
- 20 12. A topical composition according to claim 11, characterized in that the silver salt is selected from among silver sulfadiazine, silver acetate, silver benzoate, silver carbonate, silver chloride, silver iodate, silver iodide, silver lactate, silver laurate, silver nitrate, silver oxide, silver palmitate, and silver salts of  
25 proteins.
13. A device for insertion in a sexual canal, characterized in that the device is coated with a composition accorded to any of claims 1-12.
- 30 14. A device for insertion in a sexual canal, characterized in that the device is impregnated

with a composition according to any one of claims 1-12.

15. A device according to claims 13-14, characterized in that the device is a condom.

5 16. A device for insertion in a sexual canal, characterized in that the device is coated with a composition comprising an effective antiviral amount of a biguanide.

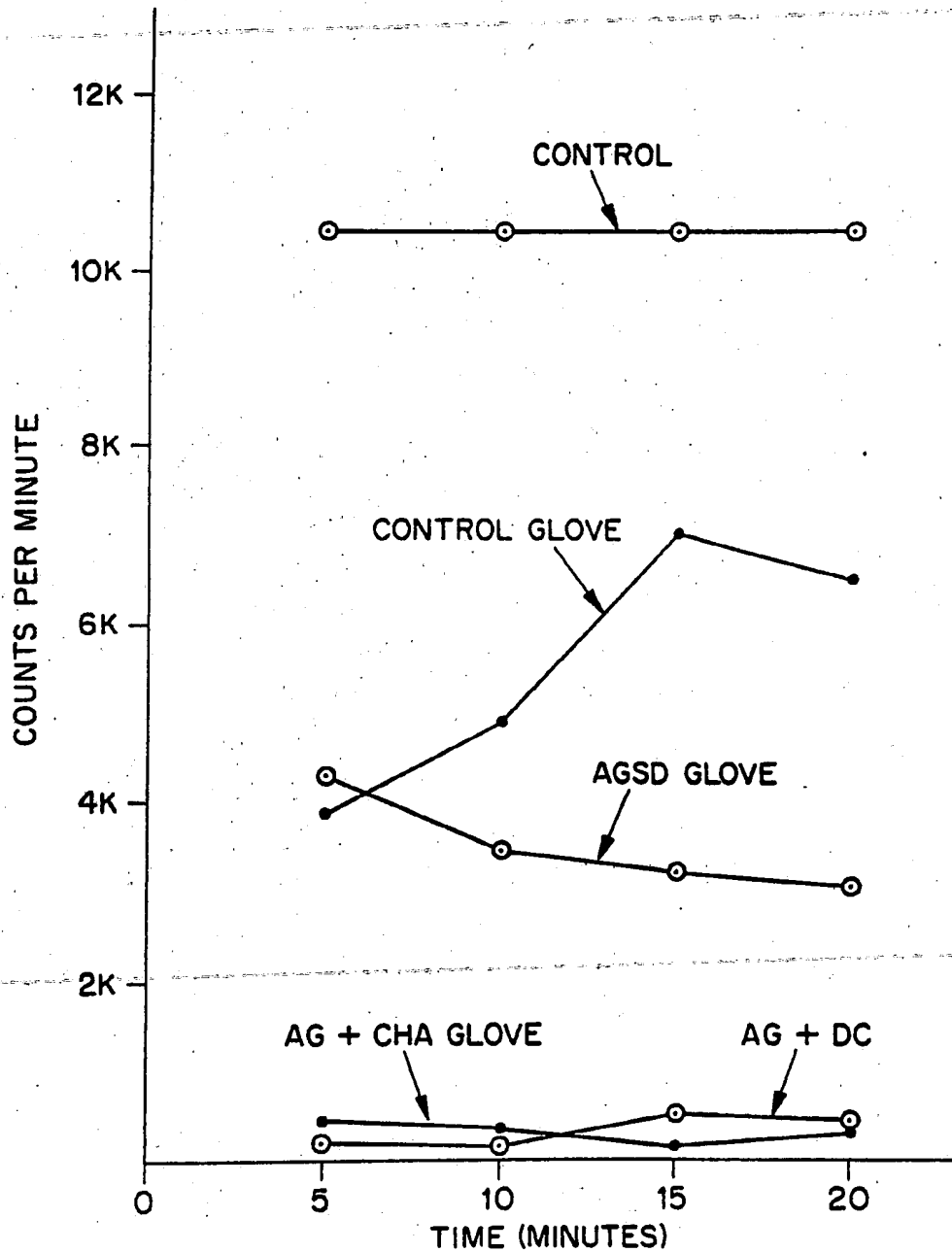
10 17. A device for insertion in a sexual canal, characterized in that the device is impregnated with a composition comprising an effective antiviral amount of a biguanide.

18. A device according to claims 16-17, characterized in that the device is a condom.



1/1

## EFFECT ON HEPATITIS B VIRUS



# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/04642

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC IPC(5): A61K 31/155; A61K 37/14; A61K 31/635; A61K 31/28 U.S.Cl.: 514/635; 424/618; 514/6; 514/157; 514/495; 128/832; 128/844																	
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched <sup>7</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border: 1px solid black; padding: 5px;">Classification System</th> <th style="border: 1px solid black; padding: 5px;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">U.S.</td> <td style="border: 1px solid black; padding: 5px;">514/635,6,157,495; 128/832,844</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup></div> <p>Chemical Abstracts Service-Online: (silver) (and/or), (guanidine or (chlorhexidine(w)gluconate)) and (((acquired(w)immunodeficiency(w)syndrome) or (Aids) or (viral ?) or (hepatitis)))</p>			Classification System	Classification Symbols	U.S.	514/635,6,157,495; 128/832,844											
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<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; border: 1px solid black; padding: 5px;">Category <sup>*</sup></th> <th style="border: 1px solid black; padding: 5px;">Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup></th> <th style="border: 1px solid black; padding: 5px;">Relevant to Claim No. <sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">Chemical Abstracts, Volume 102, page 304 (1985) abstract no. 128281; (G.B. Boudouma, M. et al., "A simple method for evaluation of antiseptic and disinfectant virucidal activity"). See the entire abstract, lines 1-11.</td> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">1-11 and 14-16</td> </tr> <tr> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">Chemical Abstracts, Volume 101, page 8 (1984) abstract no. 221999p (Fr., Quero, A.M. et al., "Determination of the virucidal activity of antiseptics by a gel filtration method"). See the entire abstract lines 1-11.</td> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">1-11 and 14-16</td> </tr> <tr> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">Chemical Abstracts, Volume 83, page 38 (1975) abstract no. 71620b (GB, Chang et al. "In vitro activity of silver sulfadiazine against Herpesvirus hominis"). See the entire abstract, lines 1-7.</td> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">3-16</td> </tr> <tr> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">U.S., A, 3,761,590 (FOX, Jr.) 25 September 1973, see the entire document.</td> <td style="text-align: center; vertical-align: top; border: 1px solid black; padding: 5px;">3-16</td> </tr> </tbody> </table>			Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	A	Chemical Abstracts, Volume 102, page 304 (1985) abstract no. 128281; (G.B. Boudouma, M. et al., "A simple method for evaluation of antiseptic and disinfectant virucidal activity"). See the entire abstract, lines 1-11.	1-11 and 14-16	A	Chemical Abstracts, Volume 101, page 8 (1984) abstract no. 221999p (Fr., Quero, A.M. et al., "Determination of the virucidal activity of antiseptics by a gel filtration method"). See the entire abstract lines 1-11.	1-11 and 14-16	A	Chemical Abstracts, Volume 83, page 38 (1975) abstract no. 71620b (GB, Chang et al. "In vitro activity of silver sulfadiazine against Herpesvirus hominis"). See the entire abstract, lines 1-7.	3-16	A	U.S., A, 3,761,590 (FOX, Jr.) 25 September 1973, see the entire document.	3-16
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>*</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>																	
<b>IV. CERTIFICATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">08 JANUARY 1990</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">12 FEB 1990</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">International Searching Authority</td> <td style="border: 1px solid black; padding: 5px;">Signature of Authorized Officer</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">ISA/US</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">             RAYMOND J. HENLEY III         </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	08 JANUARY 1990	12 FEB 1990	International Searching Authority	Signature of Authorized Officer	ISA/US	 RAYMOND J. HENLEY III							
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ISA/US	 RAYMOND J. HENLEY III																

## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A

U.S., A, 4,415,565 (WYSOR) 15 November  
1983, see the entire document.

3-16

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE<sup>1</sup>

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers \_\_\_\_\_, because they relate to subject matter<sup>12</sup> not required to be searched by this Authority, namely:
2. ☐ Claim numbers \_\_\_\_\_, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out<sup>13</sup>, specifically:
3. ☐ Claim numbers \_\_\_\_\_, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING<sup>2</sup>

This International Searching Authority found multiple inventions in this international application as follows:

The lack of unity of invention is set forth as follows:

(See Attachment sheet 1)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

PCT/US89/04642  
Attachment sheet 1

Group I Claims 1-2, 6-10 and 14-16 drawn to compositions for inhibiting transmission of sexually transmitted diseases including AIDS and hepatitis using an effective amount of a biguanide and a detergent and a carrier;

Group II Claims 3-11 and 14-16 drawn to compositions for inhibiting transmission of sexually transmitted diseases including AIDS and hepatitis using an effective amount of a biguanide, a silver salt compound, a detergent and a carrier; and

Group III Claims 12-16 drawn to compositions for inhibiting transmission of hepatitis B virus using an effective amount of a silver salt compound.

A telephone restriction requirement was made on January 8, 1990 and Dr. Larson, attorney for applicants elected Group I-III agreeing to pay for the international search of additional inventions II-III.